Interactive and Structural Complexity in the Flight Training Environment (A “Wicked Problem”)

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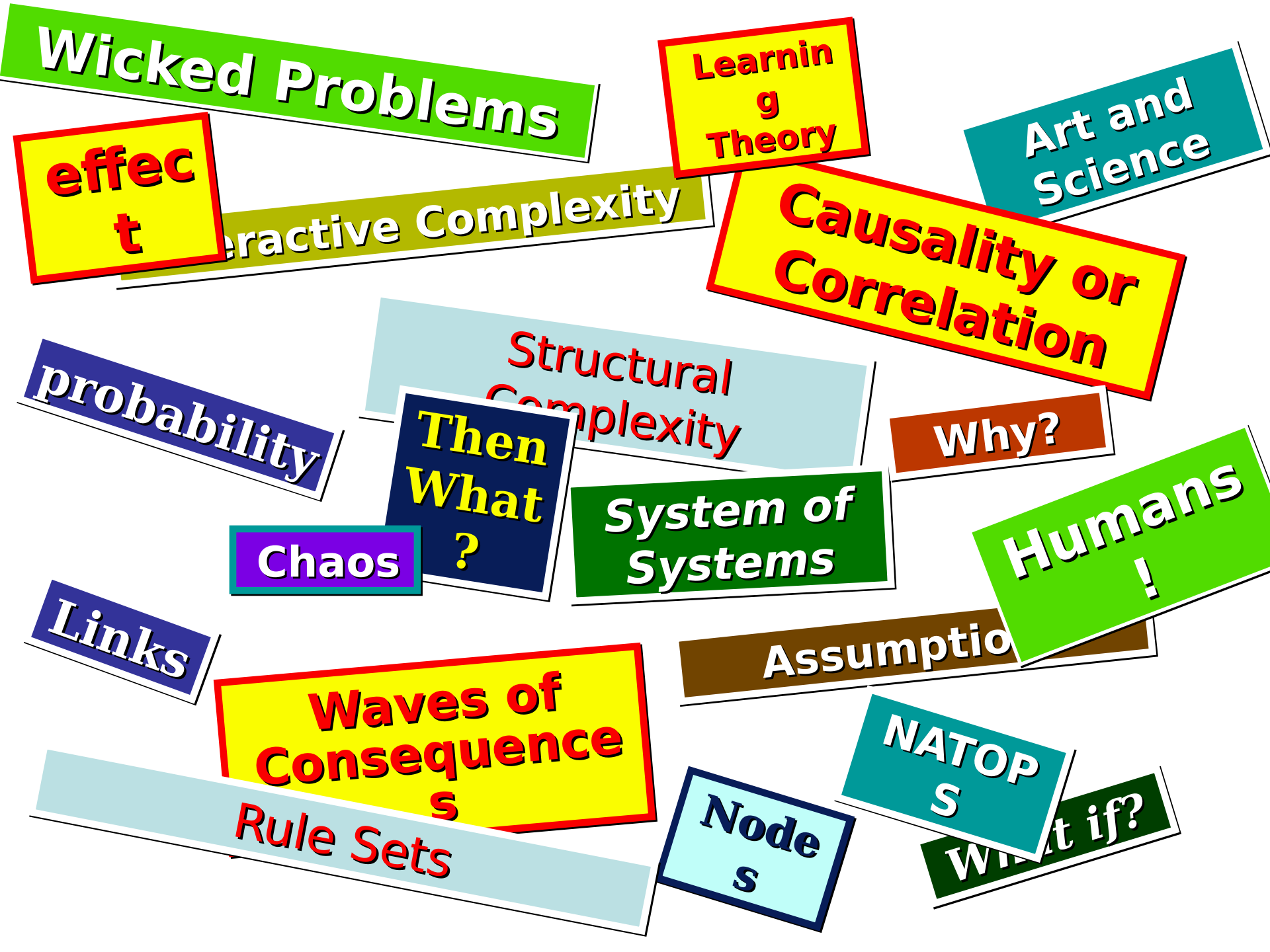
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Discussion Themes

- Recognize and challenge assumptions.
- Zoom out! (instructing and flying are different)
- Work to reduce ambiguity and risk through better situational awareness but…
- Be prepared for human-induced chaos.
- Ask simple but difficult questions: What if? Then what? Why?
- Spend time thinking!

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First things first!

- Can we analyze our training environment in systemic fashion?

- What are the elements of our “system?”
- What are the outcomes we seek from the “system?”
- What do/can we control?

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Analyzing our Training Environment by Challenging Assumptions

- Reduce ambiguity through assessment:
  - *What do we know we know?*
  - *What do we think we know?*
  - *What do we hope we know?*
  - *What do we need to know?*
  - *What can we not know?*
- What if we answer wrong? Increased risk?
- A systems approach can help

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What is our framework of outcomes?

- Actions and reactions in the environment are:
  - *Predetermined*
  - *Possible*
    - Likely
    - Unlikely
  - *Impossible*

When someone tells you something is probable, ask for a number!

(Probability is based on experimentation.)

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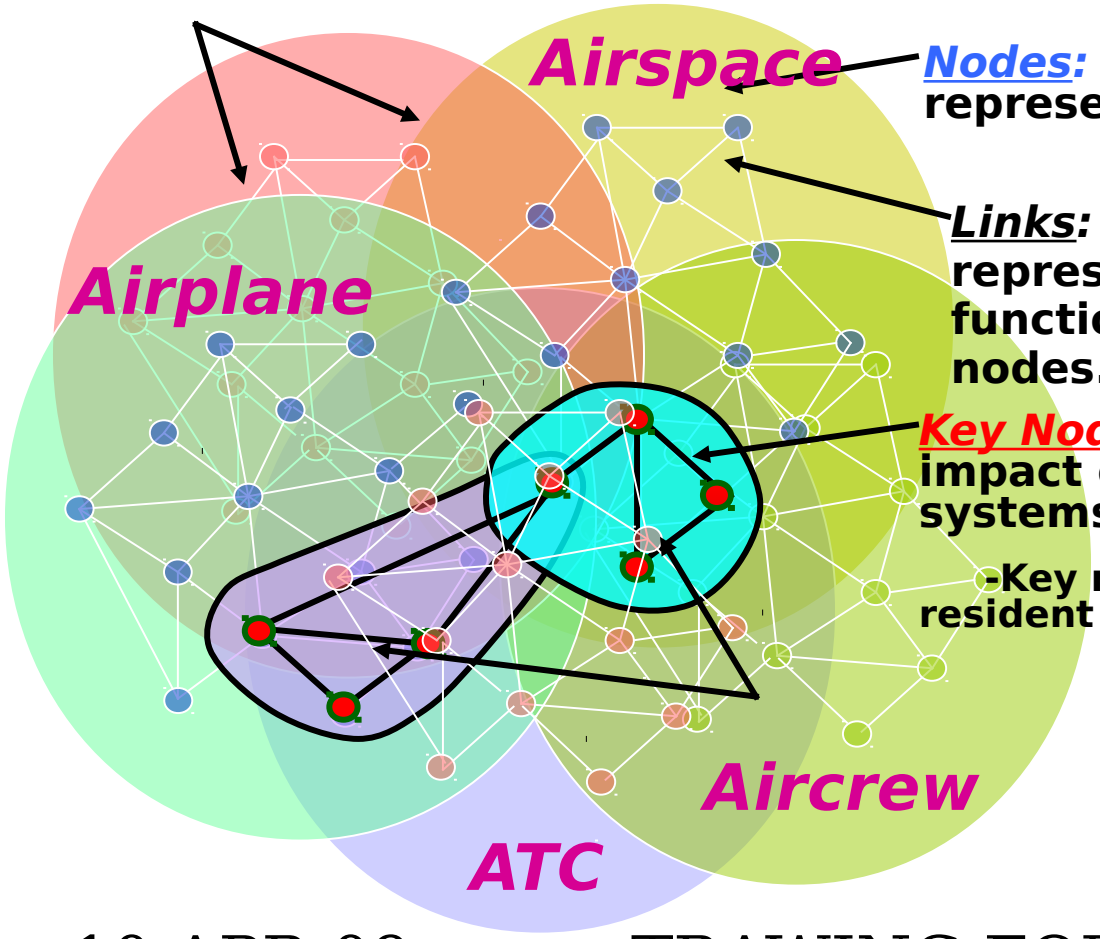
System of Systems Analysis (SoSA)

Systems: **functionally, physically, and/or behaviorally related groups of regularly interacting or interdependent elements**

Key Definitions…



Nodes: **Elements of a system that represent a person, place or thing.**

Links: **Elements of a system that represent a behavioral, physical, or functional relationship between nodes.**

Key Nodes: **A node that has critical impact on the entire system of systems.**

-Key nodes are likely to be linked to, or resident in, multiple systems.

Adapted from Joint Doctrine

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Can you describe our "system"

- Examples of nodes?
  1.
  2.
  3.
- Examples of links?
  1.
  2.
  3.

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Systems

- Should be analyzed based on both system structure and linkages.
- Structural complexity: number of nodes
- Interactive complexity: relationships between nodes – how they interact

- Can you give an example of a structurally complex, interactively simple system?

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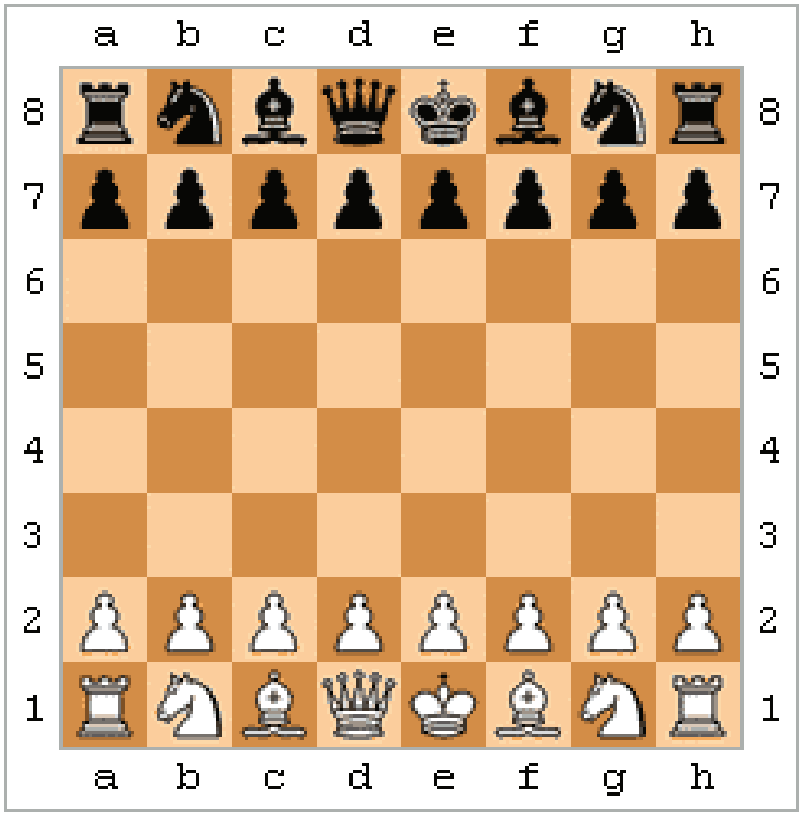
What is Interactively Complex?



Let's play chess!

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The Operational Environment of Chess

- How many:
  - *Players?*
  - *Possible Outcomes?*
  - *Pieces?*
  - *Spaces?*
  - *Basic moves?*
  - *Average legal moves per turn?*
  - *Possible starting moves?*
  - *Possible permutations to the outcome?*

Does anyone have a super computer handy?

Is Chess Complex?

- Shannon's number:
  - *10^{120}*
- Is that BIG?
- Anyone know how many atoms are estimated to be in the universe?
  - *$4x10^{79}$ and 10^{81}*
- **Now lets add a little humanity!**

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What if?

- Our opponent has different rules?
- His objectives and end state differ from ours?
- The spectators begin moving pieces?
- ENS Pawn doesn’t like Boomer IP Rook and refuses to move to an adjacent space?
- Ranger Solo Knight misinterprets his orders?

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Then what?

- How complex is the environment now?
- Our assumptions were wrong?
- Are others irrational because we don't know their rules? Because they don't follow ours?
- If our opponent is only playing to capture all of our pawns might we both claim victory?

Is flight training more complex than chess?

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What does this mean??

- The proximate cause of effects in interactively complex situations can be difficult to predict.
- **Caveman Aviator translation:**

Did your instructor action cause the desired effect in your student?

Let's Demonstrate!

A “simple” system?

- Structurally simple with two nodes (you and me).

- But interactively complex?
- Known rules and desired effect.
  - *Please lay your hand flat on the table.*
  - *When I raise my right hand, you raise yours.*

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What happened??!!

- Causality or correlation?
- Did you raise your hand because I raised mine or due to some other stimulus?
- What links exist between the nodes?
- How did the human element affect the outcome?

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So what?

- Interactively complex systems like those encountered in our flight training environment present “wicked” problems. Despite this, working to understand nodes and links in the system and how they might interact reduces ambiguity and correspondingly risk, thereby increasing our chances for success.
- Need to balance the art with the science.

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